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Photo by Leonard Lee Rue, III

Though an Exceedingly Popular Game Animal With Varmint Hunters, Few Know Much About the Woodchuck Itself, or Its Life and Habits—and Even Less About How It May Prove Beneficial in Man's Fight Against Several Dread Diseases. Here Is an In-Depth Report, Based on Years of Study by a Leading Authority, on . . .

The Pennsylvania Woodchuck

By Robert L. Snyder, Sc.D.
Acting Director, Penrose Research Laboratory

ONE DAY LAST summer I was showing a small group of fifth-grade students through the animal quarters at the Penrose Research Laboratory at the Philadelphia Zoo. At the time, about 50 woodchucks (marmots, groundhogs, etc.) were caged in the room. I thought the children would enjoy a close look at these impressive rodents. We had already observed the standard white laboratory mice and rats used for medical research, so I pointed out the fact that mice, rats and woodchucks were related species in that all were rodents or so-called gnawing animals.

One small boy evidently wasn't very impressed, for he asked me, "What are woodchucks good for?"

"Well," I answered him, "woodchucks are good for lots of things. They're good to hunt, they're good to eat, and they're especially good subjects to study heart disease." It occurred to me after all my young guests had left that a lot of people don't fully appreciate what animals are good for.

For example, in this day of enlightenment by the educational media of television and radio, most woodchuck hunters are probably aware that heart disease, stroke, and cancer are the three most important diseases afflicting mankind. What they probably don't know is that their favorite game animal is equally prone to develop these dreaded diseases. This fact came to light as a result of a study of the causes of death among wood-

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chucks maintained at the Penrose Research Laboratory from 1960-1969. Actually, in the past ten years woodchucks have received a lot of attention from scientists and much has been learned about their diseases, their physiological mechanisms, and their behavior. Most of this new knowledge would naturally be of interest to the readers of GAME NEWS, and for this reason it seemed like a good idea to summarize the more pertinent results of my own studies on Pennsylvania woodchucks.

The woodchucks maintained in the laboratory cages were captured at the Letterkenny Army Ordnance Depot near Chambersburg when 3-5 months of age. The oldest of these were nine years old during April, 1969; thus, collectively they are probably the oldest groundhogs in captivity. The selection of the Army Ordnance Depot as a source of woodchucks wasn't entirely an accident, for I had spent three years on a field study there from 1956-1959. Habitat conditions were nearly ideal at that time and the area supported extremely dense populations of woodchucks. The objective of the study in the simplest terms was to find out all there was to know about woodchucks. My first job was to devise the best methods of trapping these animals alive, because handling woodchucks for the purpose of taking weights and measurements, making parasite counts and collecting urine and blood for medical studies was required.* Also, marking animals with numbered, metal ear tags before their release made it possible to learn a lot about the species' private life. How fast they grew, how far they traveled, how much they ate, how long they nursed their young—these are only a few of the questions answered by trapping and retrapping individually identified animals.

My first experience with a woodchuck in a trap was a bit nerve-wracking. In September, 1956, I experimented with some box traps, but these were designed for cottontail rabbits. Being new at the game of handling live woodchucks, I had consulted the scientific literature beforehand and had come up with a wire cone that fit over the mouth of the box trap and which tapered down to a wire ring three inches in diameter. The device consisted of several strands of number nine wire running from a large rubber band around the mouth of the trap to the metal ring. This apparatus could be collapsed around the animals and held or tied together at the end. Unfortunately, the woodchuck in the trap wouldn't turn around regardless of the stimulus. When I tried to pull the animal from the trap by the tail, I found out that a medium-size groundhog can be very stubborn indeed. This animal was able to brace itself against the sides of the box and refused to come out backwards.

I finally had to dismantle the trap, and at this stage I ended up holding a very angry marmot by his tail. I wasn't sure then whether a woodchuck could turn up on itself to bite, so I was a bit apprehensive. However, I soon realized that the weight of the average woodchuck made it vulnerable to the tail hold. It turned out that this was a safe way to carry woodchucks from one spot to another. The young ones are lighter and more agile but can still be carried by the tail if one is careful to shake them when they try to turn back toward the hand.

MY EXPERIENCES in 1956 led me to make some larger box traps measuring 30 x 11 x 9 inches. With these traps I was able to trap more than 2000 woodchucks over the next three years.

Marmots are true hibernators; i.e., they sleep through the winter in an underground burrow. The whole process of hibernation is still a mystery to scientists. A hibernator is able to reduce its body temperature and slow its vital life processes to a bare minimum. The little bit of energy required during this time is supplied from fat depots which are built up over the summer when food is plentiful. Scientists are anxious to learn the mechanisms of hibernation for many reasons. An immediate application would be in the field of medicine for patients requiring major surgery and in the treatment of certain diseases.

Each year during October there was a noticeable reduction in woodchuck activity, and by November 1, which corresponds closely to the traditional opening of the small game season, a woodchuck was a rare sight. Hunters occasionally bag a woodchuck while hunting rabbits and pheasants, especially in the southern part of the state. My experience with October and November woodchucks leads me to believe that those above ground after the middle of October in southcentral Pennsylvania are diseased or otherwise handicapped and therefore have not been able to store sufficient fat for hibernation. During the months of October, 1956-1958, I shot 38 marmots, 22 young of the year (11 males and 11 females) and 16 adults (11 males and 5 females). The young were generally healthy;

however, the adults suffered from various afflictions—malocclusions or overgrown incisor teeth (2), encysted tapeworm larvae (1), and kidney diseases (all 16). The old animals, with two exceptions, were not as fat as they should have been. Hence, it would appear that woodchucks with sufficient fat stores commence their winter fast on about October 1 in southcentral Pennsylvania, but others for various reasons are forced to remain above ground much longer. Some of the animals no doubt perish during the winter because they cannot accumulate enough fat. Young of the year probably require a bit longer to store sufficient hibernation fat, which would explain their presence above ground.

DURING my first winter on the study area I attended classes at Johns Hopkins University on weekdays and excavated woodchuck burrows on Saturdays in search of hibernating woodchucks. My first dig on December 18, 1956, was successful, and more by luck than good management I found a hibernation chamber containing a 10-pound adult female. My good fortune is indicated by the fact that after the first dig I was able to locate hibernating woodchucks on the average in only one of 20 excavations.

A burrow system is an elaborate set of underground tunnels (up to 40 feet-plus in length) with many branches and dead ends. The hibernation chamber at the end of one of the tunnels is a large bowl-shaped hollow lined with several bushels of leaves, dried grasses, and even scattered corn shocks. The roof is generally three or four feet below ground level.

The female located on December 18 was wide awake when the shovel broke through her chamber. She was hidden deep in the middle of the nesting material and made a loud, menacing, clicking noise by meshing the incisors rapidly when I touched her back. The noise is difficult to describe but is a little bit like the sharp staccato sound of a typewriter. Studies of hibernating rodents in the laboratory show that complete arousal from hibernation requires about six to seven hours. A loud noise, a change in temperature, or a touch, is a sufficient stimulus to initiate arousal. Thus, the first sounds of the pick and shovel may have started the arousal process. Since the first excavation took more than six hours, the occupant had ample time to arouse herself.

February 2 is the day on which, according to legend, the groundhog first emerges from hibernation. Of course, the legendary ability of this animal to predict the weather has always been viewed with scepticism by scientists. My professor at Johns Hopkins already had warned me that I should make a special effort to record the first activity at the end of winter. He also suggested that to be sure I didn't miss the first woodchuck to emerge I should make periodic checks of burrow entrances starting on January 1 each year. I found no signs of woodchucks above ground during January of 1957. I set out with little enthusiasm on February 2 that year and was more than a bit surprised when I found unmistakable evidence of an active woodchuck in the form of mud freshly excavated at a burrow entrance. The woodchuck's footprints were clear in the soft mud. I was also rewarded by an actual sighting of this particular animal at high noon the same day. This animal saw his shadow without a doubt, for it was a bright sunny winter day.

Only a few animals were active during the first week of February, but the number increased toward the middle of the month. In 1958, the local residents missed Groundhog Day completely, but only by one day. In 1959, they were one day early. In retrospect, even scientists would have to admit that February 2 is an accurate date for the emergence from hibernation at Chambersburg. Farther south the animals emerge a few days earlier and as far north as southern Canada they probably sleep for at least a month longer.

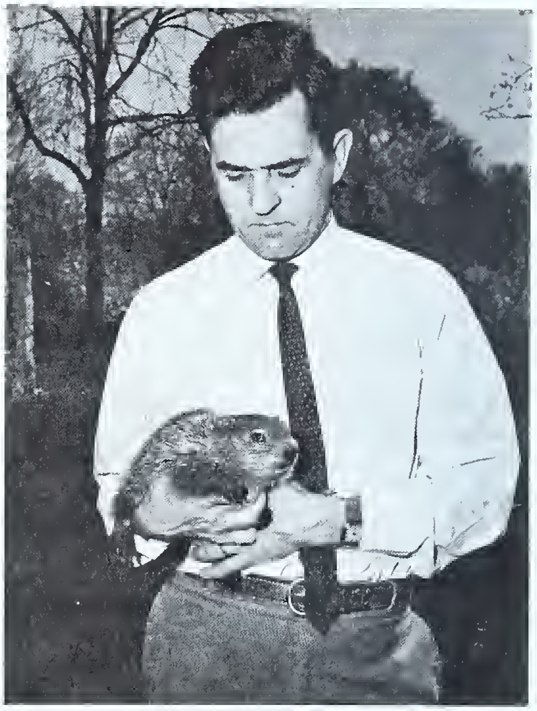
Since there were animals above ground, I set out traps and followed their tracks in the snow to get an idea of the range of movements. Animals were active above ground for only one or two hours during the middle part of the day, and for this reason trapping success was poor. From 1957 to 1959 I caught 25 animals. Their sex, weights and ages revealed an interesting pattern. First, only two of the 25 were females, one trapped on February 22 and the other on February 26. Second, only one of the males was a youngster (born the year before); 24 were mature adults (at least 2 years old). After March 1 the sexes were equally represented in the traps which can lead to only one conclusion—the females stayed in their dens for 30 days longer.

Many of the woodchucks were sacrificed for studies of physiology and disease. The firearm selected for collecting specimens was an ordinary 22-caliber rifle equipped with a 6X scope; the cartridges were Long Rifle hollow points. The study area was in the restricted ammunition storage area of the ordnance depot and closed to the hunting public. The animals were always shot at close range (25-50 yards), since the objective was merely to collect the desired animal with a clean kill. At first the animals were shot in the head, but the bullet very often destroyed the pituitary, a small endocrine gland at the base of the brain. Since this organ was required for medical studies another point of aim, the neck, was tried. This proved to be an excellent choice. The bullet usually hit the spinal column and at least one of the jugular veins and dropped the animal on the spot.

A careful dissection of the visceral organs, with special attention paid to the fat depots and the reproductive organs, added a tremendous amount of information concerning the woodchuck's life cycle. For example, weighing the fat deposits in the abdominal cavity provided information on the efficiency of hibernation. The fact that a considerable portion of the fat stored during the summer was still present after hibernation provided some new insights. Stores of fat were obviously an important source of energy during the breeding season in early March when green foods were not abundant. The breeding males especially relied on these stores during February, since observations showed that they ate little, if any, at this time. Females utilized this fat during pregnancy and even had a portion left over for the nursing or lactation period.

WOODCHUCKS gain weight steadily for about six months, then lose weight for the next six months. This cyclic change in weight is repeated again and again through life. It would appear that woodchucks attain progressively higher weights each year for the first few years of life, at least. My data show a gradual diminution in the rate of increase for the first three years of life.

Animals of unusual size are of considerable interest to hunters. The largest woodchuck collected during my study, a male, weighed 15 lb. 12 oz. on September 4. This animal when recaptured again on March 5 the following year weighed only 9 lb. 9 oz. So I would suggest that hunters wanting a giant trophy should try their luck during September. The largest female weighed 12 lb. 12 oz. on August 28. The weights of these animals are not unusually high when compared with the average weights of the adults collected during September and October, but they are the highest of more than 2000 animals handled. I would judge from my data that reports of 40-pound woodchucks which sometimes appear in the newspapers are greatly exaggerated.



ROBERT L. SNYDER, Acting Director, Penrose Research Laboratory, Philadelphia, with baby woodchuck born in the laboratory on Groundhog Day.

The loss of weight during hibernation was of special interest. Measures of weight loss were calculated by averaging the weights of animals captured just prior to hibernation and then subtracting the average weight of the animals weighed soon after emergence. Total weight losses during the period of decline ranged from 20 percent of the prehibernal weight of young males (less than a year old) to 38 percent of that of adult males. Young females lost about 30 percent of their weight during hibernation and the immediate post-hibernation period and adult females about 35 percent. In general, the metabolic rate of animals in hibernation is between 1/30 and 1/100 of the resting metabolic rate at normal body temperature. The weight loss of woodchucks during actual hibernation works out to approximately 0.2 grams per day per kilogram of body weight. In contrast, a scientist studying another species of ground squirrel in the laboratory found that 4126 hours of hibernation required only 70 calories of energy, while 330 hours of wakeful activity used up 597 calories. These data emphasize again the extreme efficiency of the physiological mechanisms of hibernation.

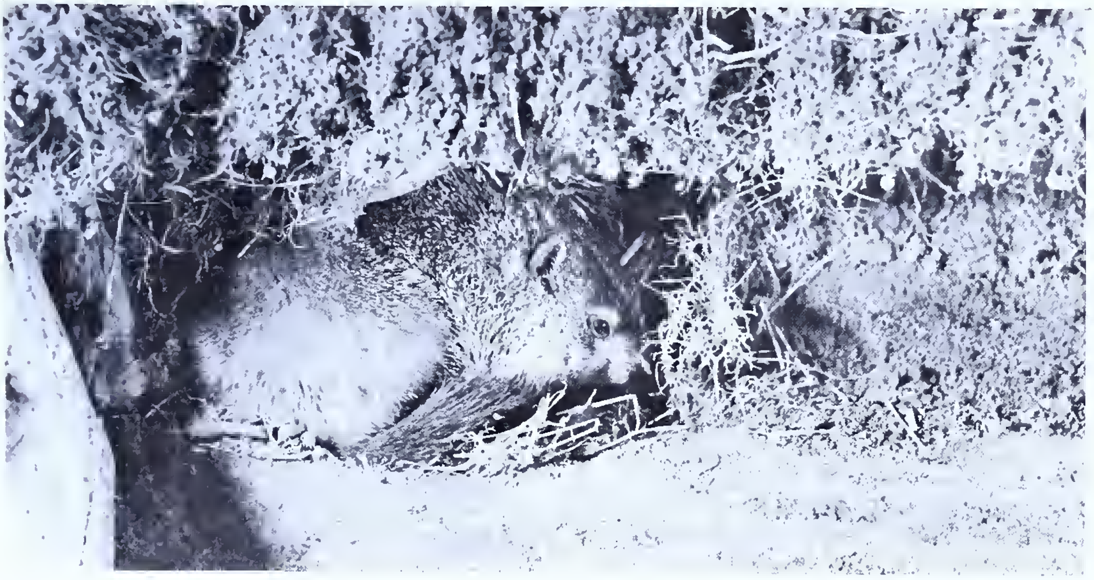
The breeding season begins immediately after hibernation. The testes, which undergo a cyclic, seasonal change in size and function, have already developed considerably when the males emerge in February and reach their maximum weight of roughly 10 grams during March (1 oz. = 28.35 grams). The adult males during February and March are extremely aggressive and fighting is fierce and sometimes bloody. Movements during February were measured after each new snowfall. The males moved from one burrow system to another, covering distances of 200 to 300 yards, usually early in the morning or at midday. It was during their travels that contacts between males resulted in bloody skirmishes.

ONCE I SAW three animals involved in a battle which lasted 25 minutes. A woodchuck fight is a fierce spectacle. The incisor teeth of these large ground squirrels are formidable weapons and ripped ears and torn lips were noted on many of the males trapped at this time. Another common wound was inflicted on the tail with the result that approximately 25 percent of the adult males had bobbed tails. The vanquished male in these encounters often lost his tail when he turned to run. I saw the tail hold on only one occasion and although in this particular conflict the appendage was not amputated, I can vouch for the bulldog-like grip of the victor. A short tail was an added hazard to those handling trapped woodchucks, but I must admit that the danger was mostly psychological because there was usually enough tail left for a firm grip.

Considerable information on reproduction was obtained by careful dissections of reproductive tracts of animals shot during the period from March through June. Visible embryos were first observed in the uterus of a female shot on February 22. Technically, the body *in utero* is called an embryo until the body parts and the visceral organs are completely formed. The gestation period of the woodchuck is approximately 31 to 32 days. The embryonal development is completed early, probably during the first third of pregnancy. From this point on the unborn baby is called a fetus and further development is simply a matter of growing larger and developing hair.

Parturition is the scientific term for bringing forth offspring. The baby woodchuck, like other so-called placental mammals, is attached to the maternal blood supply by a placenta while in the uterus. The baby obtains oxygen and nutrients and gets rid of carbon dioxide and metabolic wastes through this vascular organ. At parturition the placenta is detached, but it leaves a bloody scar on the uterine wall. This scar heals but remains visible for several months, even up

WOODCHUCK DEN HAS BEEN DUG AWAY to expose cross-section. Tunnels may extend forty feet, have numerous branches and dead ends.



to a year in a few instances. One can count the uterine scars of the females killed during the hunting season to determine how many offspring there had been in the last litter. Biologists use this technique to determine the productivity of certain populations of mammals.

Placental scars were not found before April 1 and embryos and fetuses were not found after April 21. From this evidence one can say confidently that with few exceptions woodchucks are born during the first three weeks of April in southcentral Pennsylvania. This statement is based on dissections of 68 female woodchucks shot during the critical three-week period in 1957 and 1958.

Lactating females were collected from April 1 to June 9 and 154 females were examined during this period. A rough calculation from April 10, the midpoint of the parturition period, to May 23, the point at which half the females had ceased lactating, indicated a lactation period of 44 days.

A recapitulation of these data gives a rather accurate description of the reproductive cycle. The adult males emerge from hibernation about three to four weeks before the females and the sub-adult males. The majority of the sexually mature females are bred during the first three weeks of March and most of the young are born during a period from April 1 to April 21.

THESE STUDIES also demonstrated that 75 to 80 percent of the females each breeding season became pregnant. Also, those females not impregnated were invariably young of the previous year, the so-called yearling females. Actually the percentage of yearling females becoming pregnant varied from year to year but never exceeded 55 percent. The approximate average litter size, which was calculated by counting the number of embryos or fetuses and the placental scars, was 3.42 in 1957 and 3.97 in 1958. The largest litter recorded in this manner would have contained nine offspring if all had survived. Furthermore, these studies demonstrated unequivocably that Pennsylvania woodchucks have only one litter a year.

I had the good fortune to examine three young woodchucks immediately after birth in one of my captive females. Two females weighed 30 and 33 grams respectively and a male 34 grams. The babies were quite helpless, the eyes were still closed, and the hair coat was sparse. They measured 85 millimeters (3.35 inches) from tip of the nose to the base of the tail. The earliest date a young woodchuck was captured away from its home den was May 15. This young female weighed 425 grams, but was not the smallest taken. A male caught on June 5 weighed only 310 grams. From May 15 until approximately the first of June, mother and young are sighted together frequently. The young stay close to the female. They romp and play together much like young puppies and also include their mother in their play activities. The mother is very alert and protective. She brooks no interference by other adult woodchucks and will stand her ground when surprised by a human intruder as well.

THIS IS A woodchuck skull.

The approximate growth rate from birth until weaning was 16 grams per day. The calculated rate of growth from June through September was 20 grams per day for males and 18 grams per day for females.

Unlike marmots in other parts of the world, which live together in small colonies, the "eastern" woodchuck leads a solitary existence except during the breeding season. In general, one wouldn't consider them social animals. Moreover, most naturalists consider marmots to be promiscuous in their mating habits, although on this point I have my doubts. Each spring while I was on the Letterkenny study area I noted a strong pairing tendency. That is, I observed what I thought to be the same two animals occupying the same burrow system for several days in a row.

Such behavior doesn't fit the definition of promiscuity precisely, which made me curious about the makeup of these "odd couples." After an appropriate period of observation to establish the strength of the bond, I collected the two animals with two shots from the 22 rifle. The shots had to be fired in rapid succession to accomplish this feat, but in most instances it worked well enough. The two animals were often very close together, practically touching at times, but the surviving member was still not unduly alarmed by the sudden demise of his or her companion.

I was able to study 36 pairs for the required length of time, which I set arbitrarily at 7 days in succession, but only 10 of these associations were collected in the desirable manner. The associations either broke up before I could collect them or the two animals refused to cooperate by standing close together during the allotted time for shooting.

Eight of the 10 pairs included a male and a female, both sexually mature. The other two pairs were unusual. One consisted of a large, sexually mature, adult male and a small, immature, yearling male, while the other consisted of a pregnant female and a yearling female with undeveloped ovaries. The one example would indicate that a sexually mature male will tolerate an immature male. The second example indicates that we should take nothing for granted concerning woodchuck behavior.

THE LARGEST female chuck in study weighed 12¾ lbs., while the largest male went 15¾ lbs. These animals go through cyclic weight change.

Photo by Leonard Lee Rue, III

Woodchuck pairs were observed only from late February until the end of April. During April the females were nursing their young underground and for a time at least these females must have tolerated a male companion. But by the time the young appeared above ground with their mothers the males had returned to their solitary existence.

THE YOUNG are weaned by late May or early June and movements away from the home den commence almost immediately. The distances covered by these young travelers are sometimes considerable. For example, one emigrant moved 5500 feet between June 19 and July 9, 1958, then was captured again on April 24, 1959, 2915 feet away. The record distance was 10,000 feet, accomplished between June and September.

The young of the year are evidently traveling in search of favorable homesites. The traveling must of necessity be suspended during the winter hibernation period, but a small percentage of these animals take up the nomadic behavior again the following spring.

The oldsters, in contrast, are real homebodies, rarely moving more than 2000 feet within their home ranges. Some of the adult woodchucks first captured and ear tagged in 1956 were captured again in 1957 and 1958. All of these animals had remained in the same general area during the three-year period. As a matter of fact, most of them were trapped at the same trapsites or, at most, in traps 200 feet distant.

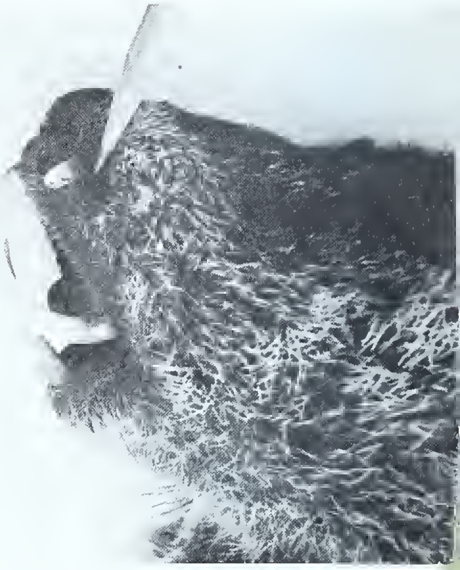
We now have a fairly good idea of the woodchuck's life in the wild, but what happens when they are brought into the laboratory? First of all, most of them accept captivity graciously. These creatures were all very fierce and wild when captured. Thus, it surprised me no end to find that a full-grown male would soon actually permit himself to be patted on the head. The old male in the first cage by the doorway likes to have his head scratched. He is also a favorite of the lab technicians and they allow him and others to leave their cages daily for exercise in the animal quarters. The male in cage Number 12, however, now nine years old, is a real old grouch and can't be trusted. Don't get the idea either that the females are by nature the gentler of the sexes. One or two of the old girls are crotchety too. Woodchucks, like people, have their own individual personalities.

Woodchucks in this laboratory didn't hibernate, probably because it was too warm and also possibly because there was no shortage of food. And although several pairs of males and females were caged together, only two litters have been born thus far. The first, a litter of seven, was born on February 23, 1963, but these young chucks died within 24 hours. At first I thought the cage environment was not suitable for reproduction but this was not true because a second litter was successfully reared in 1968. The young mother responsible, 22 months old, made the front page of a Philadelphia paper by delivering her babies on Groundhog Day. We made a small bed of straw for her in the lab cage and she nursed them faithfully for 45 days. These youngsters are fairly tame now and are still growing at this date.

It is probably significant that the litters were born during February instead of during April, which is the normal time for bearing young in nature. Scientists know that the physiological mechanisms of reproduction in many animals are governed by the length of daylight. Thus, the perception of increasing hours of daylight in the spring each year initiates the development of the reproductive organs. The lights in the laboratory are regulated by an electrical timer to allot 14 hours of light every day. So perhaps the woodchucks were confused by this turn of events.

THERE WERE deaths as well as births in the laboratory. Thus far, 30 captives have died. A detailed postmortem examination complete with microscopic examination of the tissues was conducted to determine the cause of death in each case. Ten of these animals developed cancer of the liver. This is an unusually high incidence of cancer and the exact cause is still a mystery. Other causes of death were ruptured aortas (the main artery from the heart), heart attacks from hardening of the coronary arteries, and cerebral strokes, also the result of hardening of arteries in the brain.

The pattern of diseases has created a lot of interest in scientific circles because there is an urgent need for suitable experimental animals which develop this pattern spontaneously. A satisfactory laboratory animal for medical research must develop disease patterns either identical to or similar to those which develop in man. Furthermore, the animal's lifespan should not be too long, so that the disease being studied can be expected to develop in a reasonable period of time. For example, woodchucks develop cancer of the liver within 23 months and heart attacks and strokes within 36 months. Diseases which normally take 40 to 60 years to develop in man occur in the woodchucks in roughly one-twentieth the time. Perhaps woodchucks will be ideal models for the study of heart disease, cancer, and stroke. If so, man will be the benefactor.



MALOCCLUSION is fairly common among woodchucks and a typical result is shown. If teeth had met properly, this would not have happened.

Woodchucks certainly are good for lots of things, but then, most animals are good for more than we give them credit. The majority of hunters fully appreciate the sport and pleasure derived from game animals and many have found that their sport is increased immeasurably by knowing as much as possible about the animals they hunt. Therefore, the next time a game biologist asks to check the teeth of the buck you killed or to measure the length of the spur on that cock pheasant in your hunting coat, don't be as skeptical as the fifth-grader. The biologist is trying to learn as much as possible about the game animals you hunt. In the end it will benefit us all, perhaps in ways we never thought possible.

**Dr. Snyder's woodchuck trapping was done under special permit from the Game Commission. Trapping these animals is otherwise unlawful.*